CDMA communication system.

The invention relates to a CDMA communication system comprising at least one primary station and a plurality of secondary stations, the primary station and the secondary stations exchanging CDMA signals via a communication medium, the secondary stations each comprising a modulator for modulating a respective data signal with a respective code word in order to obtain a respective CDMA signal, the modulator being embodied so as to modulate the respective data signal with an initial code word until synchronisation with the primary station is obtained, the modulator being further embodied so as to modulate the respective data signal with a respective final code word after synchronisation with the primary station has been obtained.

The invention further relates to a secondary station for exchanging CDMA signals via a communication medium with at least one primary station and to a method of synchronising a secondary station with a primary station.

A CDMA communication system according to the preamble is known from United States Patent Number 5 499 236. Code Division Multiple Access (CDMA) is a multiplexing technique which permits a number of users to simultaneously access a transmission channel. For this purpose a data signal to be transmitted is modulated with a code word, i.e. a pseudorandom binary sequence, in order to spread the spectrum of the waveform. In a receiver the original data signal can be detected by correlating the received CDMA signal with the corresponding code word. This correlation despreads the spectrum. Other CDMA signals are not despread by the correlator because their code words do not match. CDMA can be used, for example, in mobile communication systems and in interactive cable television networks.

The system capacity, i.e. the total sum of the bit rates of the users, of a synchronised CDMA communication system is limited by the maximum number of different code words, whereas the system capacity of an asynchronous CDMA communication system is limited by the interference noise. Hence, the system capacity of a synchronised CDMA

communication system is generally much higher than that of an asynchronous CDMA communication system.

In the known synchronised CDMA communication system all secondary stations which are not yet synchronised with the primary station and which want to transmit

5   data to that primary station use the same initial code word to modulate their data signals with. Next, the resulting asynchronous CDMA signals are transmitted to the primary station. The primary station then determines for each secondary station the timing difference between the received CDMA signal and a reference clock and transmits this timing difference to each particular secondary station. Next, the secondary stations can synchronise with the primary

10   station by time shifting the initial code word in accordance with the received timing differences. This process is repeated for each secondary station until synchronisation is obtained, after which a different final code word is used by each secondary station to modulate its data signal with.

In the known CDMA communication system the asynchronous use of the initial

15   code word may cause interference with the CDMA signals received and transmitted by the already synchronised secondary stations.

An object of the invention is to provide a CDMA communication system,

20   wherein the asynchronous use of the initial code word does not cause interference with the CDMA signals received and transmitted by the already synchronised secondary stations. This object is achieved in the CDMA communication system according to the invention, which is characterized in that the initial code word is substantially orthogonal to the final code words for every possible time shift of the initial code word. The invention is based upon the

25   recognition that such an initial code word does not interfere with the CDMA signals received and transmitted by the already synchronised secondary stations and is therefore very well suited for the purpose of synchronising a secondary station with the primary station.

A first embodiment of the CDMA communication system according to the invention is characterized in that all symbol values of the initial code word are equal to each

30   other. If all symbol values of an initial code word are equal to each other, that initial code word remains the same for every possible time shift of that initial code word. Hence, a time shift of that initial code word does not influence the orthogonality of that initial code word relative to the final code words.

A second embodiment of the CDMA communication system according to the invention is characterized in that the code words are Walsh-Hadamard codes and that the initial code word corresponds to the first row or the first column of the Walsh-Hadamard matrix. Walsh-Hadamard code words have ideal cross correlation properties because all the

5   Walsh-Hadamard code words are mutually orthogonal. The system capacity of a synchronised CDMA communication system can be further increased by using Walsh-Hadamard code words. If Walsh-Hadamard codes are used as code words the code corresponding to the first row or the first column of the Walsh-Hadamard matrix is an ideal initial code word as it is, for every possible time shift of that code, substantially orthogonal to all the final Walsh-

10   Hadamard code words in use by the already synchronised secondary stations.

The above object and features of the present invention will be more apparent from the following description of the preferred embodiments with reference to the drawings,

15   wherein:

Figure 1 shows a block diagram of an embodiment of a CDMA communication system according to the invention,

Figure 2 shows a block diagram of part of an embodiment of a secondary station,

20   Figure 3 shows a Walsh-Hadamard matrix H_4.

Figure 1 shows a block diagram of an embodiment of a CDMA communication system according to the invention. In such a CDMA communication system CDMA signals are exchanged via a communication medium 6 between a number of stations 2 and 4. These

25   CDMA communication stations 2 and 4 comprise at least one primary station 2, which is here a head end, and a plurality of secondary stations 4. The CDMA communication system, which may comprise further primary stations 2 and secondary stations 4, is a partly synchronised CDMA communication system. This means that some of the secondary stations 4 are

30   synchronised to the primary station 2, while other secondary stations 4 are not yet synchronised to the primary station 2.

Figure 2 shows a block diagram of a part of a secondary station 4. The part that is shown is that relating to the modulation of an input data signal 16. Operational parameters of all blocks shown are controlled by a controller (not shown). The secondary stations 4 each

comprise a modulator 10 for modulating the input data signals 16 with code words 14 in order to obtain the CDMA signals 18. These code words 14 may be generated by a generator 12. A modulator 10 of a secondary station 4 which is not yet synchronised to the primary station 2 initially modulates its data signal 16 with an initial code word 14 until that secondary station 4

5   is synchronised with the primary station 2. From that moment on the data signal 16 is modulated with a final code word 14.

Ideally, an initial code word 14 is used which is, for every possible time shift of that code, substantially orthogonal to all the final code words 14 in use by the already synchronised secondary stations 4. Such an initial code word does not interfere with the

10   CDMA signals 18 received and transmitted by the already synchronised secondary stations 4 and is therefore very well suited for the purpose of synchronising a secondary station 4 with the primary station 2. Code words 14 which have symbol values which are all equal to each other are such ideal initial code words. If all symbol values of an initial code word are equal to each other, that initial code word remains the same for every possible time shift of that initial

15   code word. Hence, a time shift of that initial code word does not influence the orthogonality of that initial code word relative to the final code words. If Walsh-Hadamard codes are used as code words 14 the code word corresponding to the first row or the first column of the Walsh-Hadamard matrix is a practical example of an ideal initial code word having symbol values which are all equal to each other.

20   Figure 3 shows a Walsh-Hadamard matrix H_4. A Walsh-Hadamard matrix H_n is defined inductively and can be calculated from a given Walsh-Hadamard matrix H_1. The rows $R_0..R_{2^n-1}$ and columns $C_0..C_{2^n-1}$ of a Walsh-Hadamard matrix H_n are orthogonal. The code words 14 may be based on the rows $R_0..R_{2^n-1}$ or the columns $C_0..C_{2^n-1}$ of such a Walsh-Hadamard matrix H_n. A code word based upon the first row R_0 or the first column C_0

25   of the Walsh-Hadamard matrix H_4 (in general: of the Walsh-Hadamard matrix H_n) has symbol values which are all equal to each other.

The scope of the invention is not limited to the embodiments explicitly disclosed. The invention is embodied in each new characteristic and each combination of characteristics. Any reference signs do not limit the scope of the claims. The word

30   "comprising" does not exclude the presence of other elements or steps than those listed in a claim. Use of the word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.